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Whether Gas Plasma Exposure can Inactivate Virus in the Room in Success

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Abstract

In Japan, many electric instrument companies attach plasma exposure and they mention that virus in the room can inactivate in success. We need to confirm and evaluate this PR is scientifically correct or not from the standpoint of third party.

Procedure

One of the electric companies above described is Sharp Co. and their PR cited from their HP is presented in Figure 1. It is in Japanese, so I explain what they mention. Gas plasma exposure produce ions (cation and anion) to bind bacteria and virus. Bound ions then change to radicals and destroy bacteria, virus and allergen and so on. We need to confirm this statement is scientifically correct or not.

As presented in Figure 2, gas plasma simultaneously produce ions, free radicals, metastables and so on. So ions do not change to radicals by gas plasma exposure contrary to Figure 1.

Figure 1: So-called inactivation mechanism by gas plasma proposed by Sharp Co.

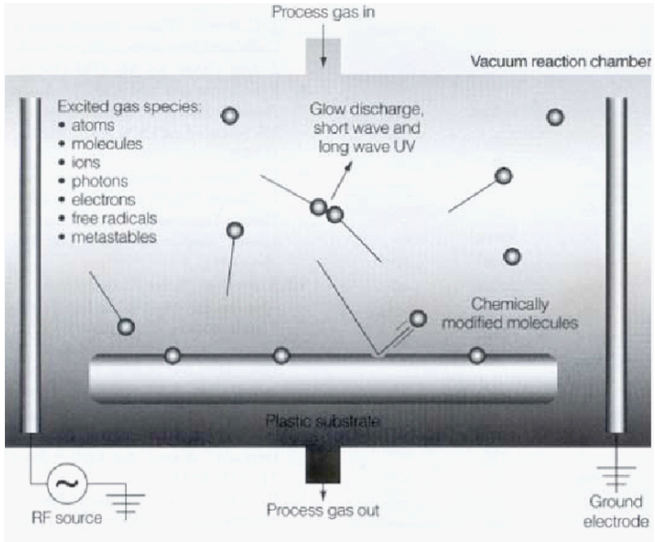

Figure 2: Active species produced from gas plasma exposure.

Life period of OH radical is around 10^{-6} to 10^{-9} second and the flight distance is around 30 cm for 10^{-2} second, indicating OH radicals do not flight long length during their life period [1].

There are several reactions related with this subject [1].

Two OH radicals bind and produce H_2O_2 at the kinetic rate of 5×10^9/M/sec.

$OH\cdot + OH\cdot \rightarrow H_2O_2$ k=5×10^9/M/sec

In addition, within the bacteria, spore, there occurs Fenton reaction as bellows;

$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + OH\cdot$ k=76/M/sec

$Cu^{+} + H_2O_2 \rightarrow Cu^{2+} + OH^- + OH\cdot$ k=4.7×103/M/sec

Even though life period of OH radical is short, they produced many

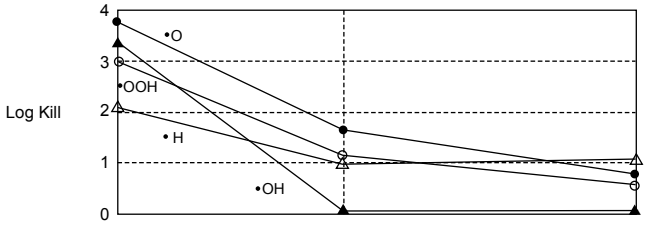

Figure 3: Comparison OH radical, H radical, OOH radical and O radical for bacteria inactivation.

The order is OH radical > OOH radical > O radical > H radical.

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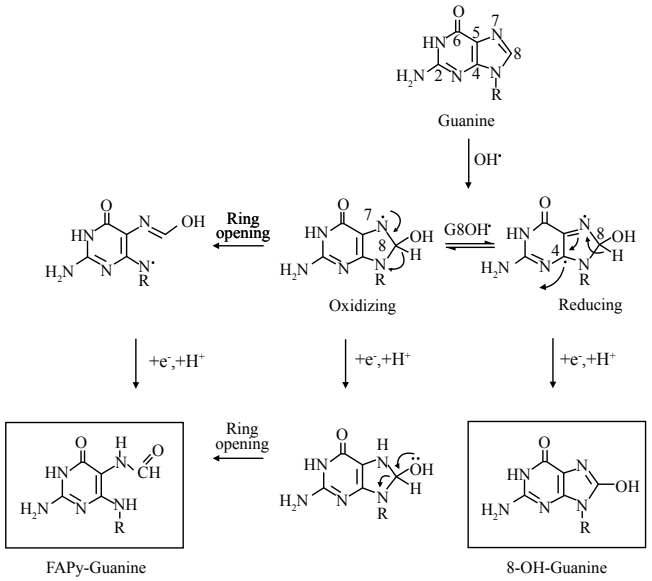

Figure 4: Production procedure of 8OHdG.

and close ones bound to produce H_2O_2 and penetrate into bacteria and spore as H_2O_2 was neutral, then using the trace amount of Fe^{2+} or Cu^+ in bacteria and spores, OH radicals again produce within bacteria or spore and OH radicals destroy them. Destruction mechanism is following; OH radicals break hydrogen bonding in protein and nucleic acid. OH radical attack DNA and produce 8OhdG (8 hydroxy guanine, Figure 4) as one example and inhibit correct hydrogen bonding formation, resulting in denaturation and inactivation of protein and DNA of bacteria and spore, respectively.

So finally we need to discuss about if virus can be inactivated by gas plasma exposure. Virus has no Fe^{2+} and Cu^+. In that means even if H_2O_2 can penetrate into within virus, no Fenton reaction occurs, so inactivation of virus by OH radical was not occurred within virus. If occurred it was only by direct attacking of OH radicals. However, as already mentioned flight distance of OH radical is around 0.003 to 0.000003 cm during life period, so from this fact virus inactivation may not occur in real status.

From these considerations, we decided that Sharp Co. might not do PR based on correct experimental result.

Reference

1. Halliwelll B, Gutteridge J (2007) Free Radicals in Biology and Medicine. Oxford University Press.